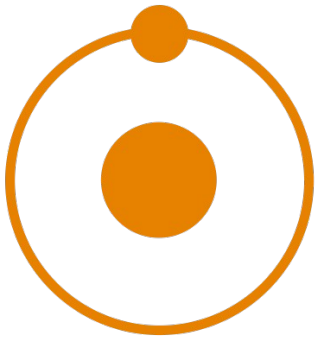


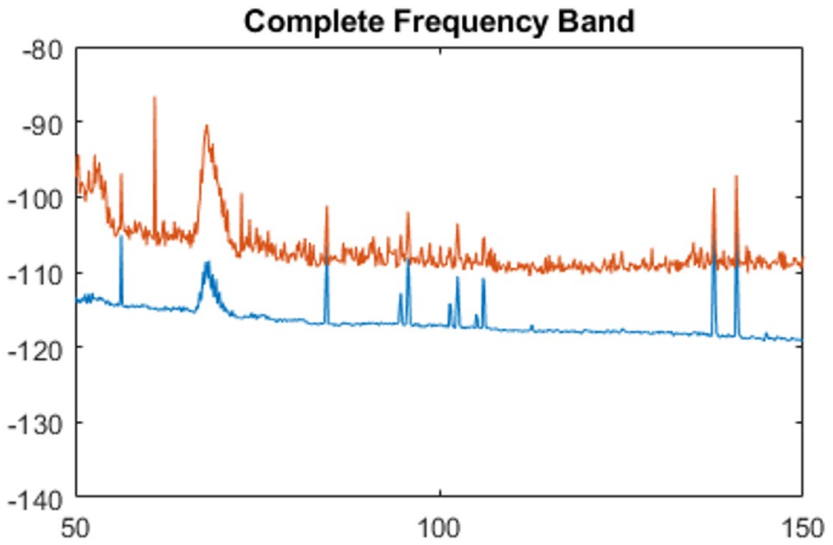
REACH

RFI Management in the REACH Pipeline

Samuel A K Leeney

The Problem

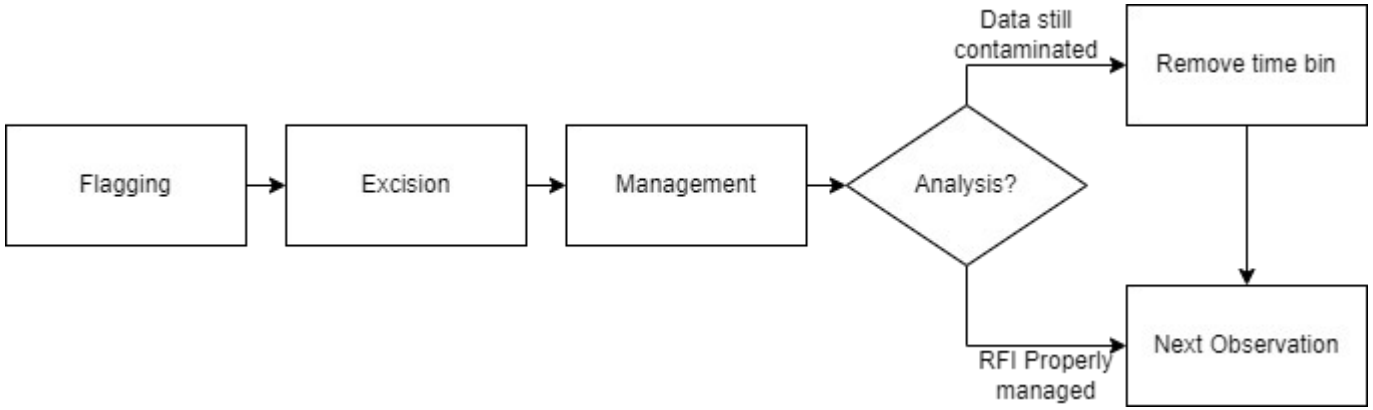
- RFI x orders of mag stronger than 21cm signal.
- 21cm signal obstructed by wide and short band RFI.
- Single frequency and emergency mobile signals particularly worrying.



The Problem


Complete Frequency Band
Mobile 1 BTX/single frequency mobile
National Emergency Alarm Radio/single frequency mobile
single frequency mobile
FM
FM
FM
FM
(108-117,975MHz)aeronautical mobile service
Non geostationaory satellite
(108-117,975MHz)aeronautical mobile service
Avg.
Max Hold

Basic Process



Excision + Management i)

-Overview

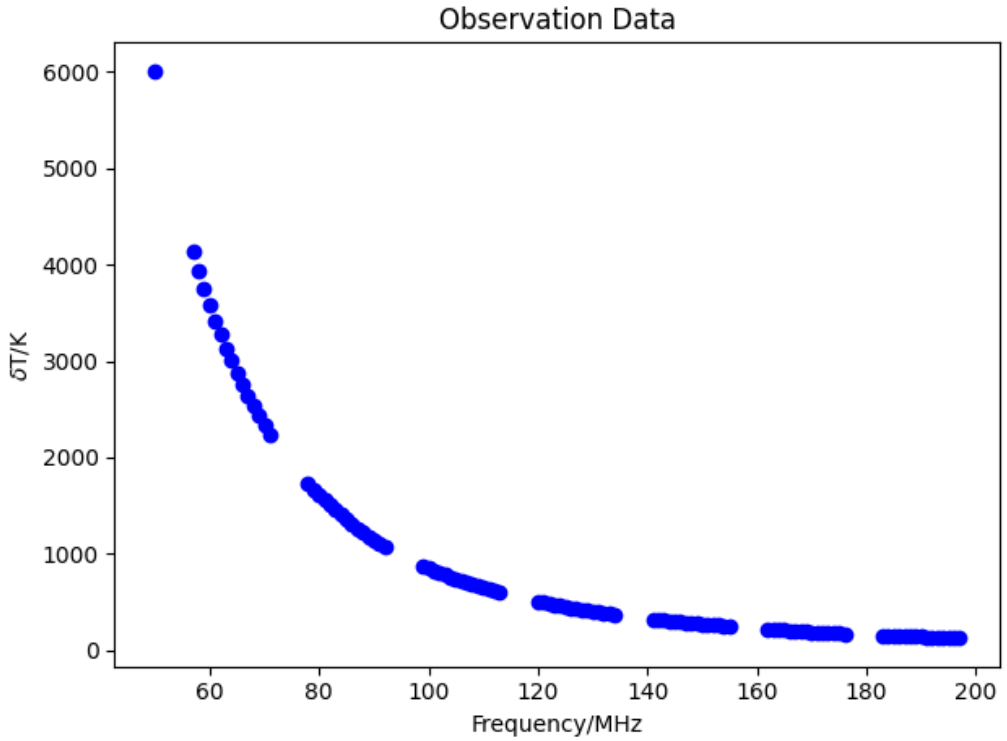
- For now, we assume ‘perfect’ flagging.
- 3 possible approaches:
  1. Excision + Inpainting
  2. Excision + Polychord
  3. Polychord Only

Excision + Management ii)

-How do we manage data excision?

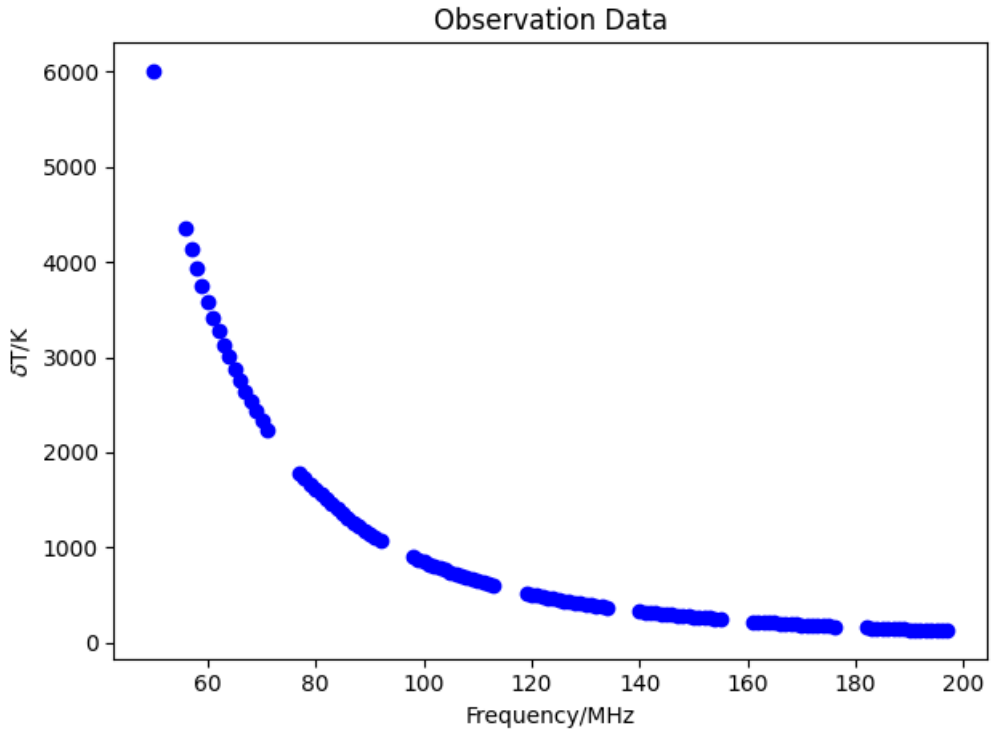
1. Delete frequency bins containing RFI.
2. Sum likelihood pdfs of remaining frequency bins.
3. Parameter estimation and Bayesian evidence calculation using Polychord.

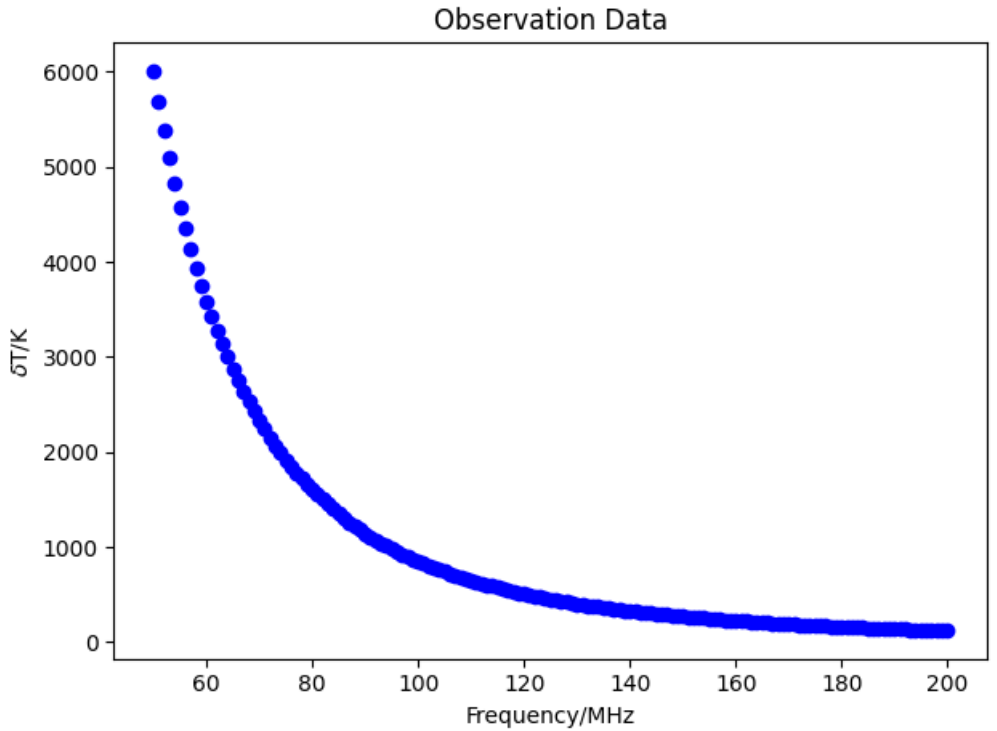
$$\log \mathcal{L} = \sum_i -\frac{1}{2}\log\left(2\pi\sigma_{\mathrm{n}}^2\right) - \frac{1}{2}\left(\frac{T_{\mathrm{data}}(\nu_i) - T_{\mathrm{model}}(\nu_i)}{\sigma_{\mathrm{n}}}\right)^2$$



Excision + Management iii)

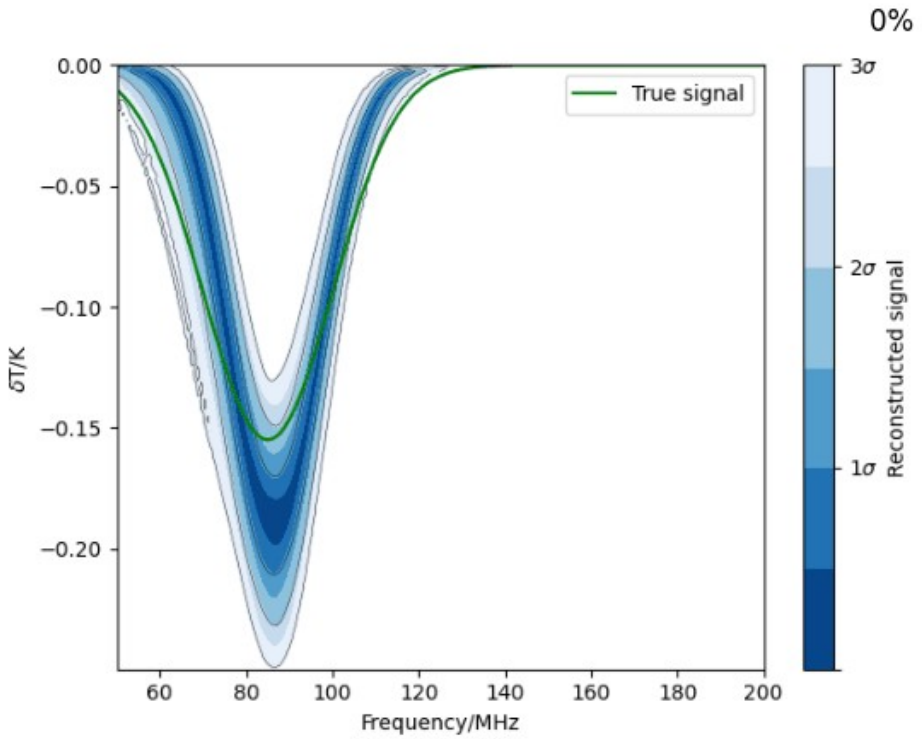
-How much data can we lose?

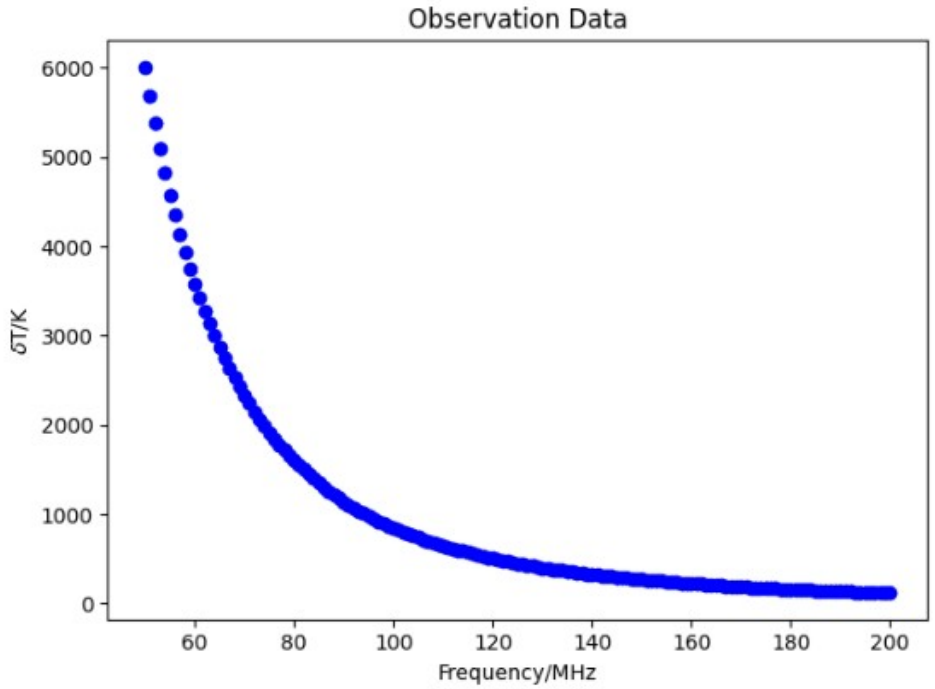




Excision + Management iv)

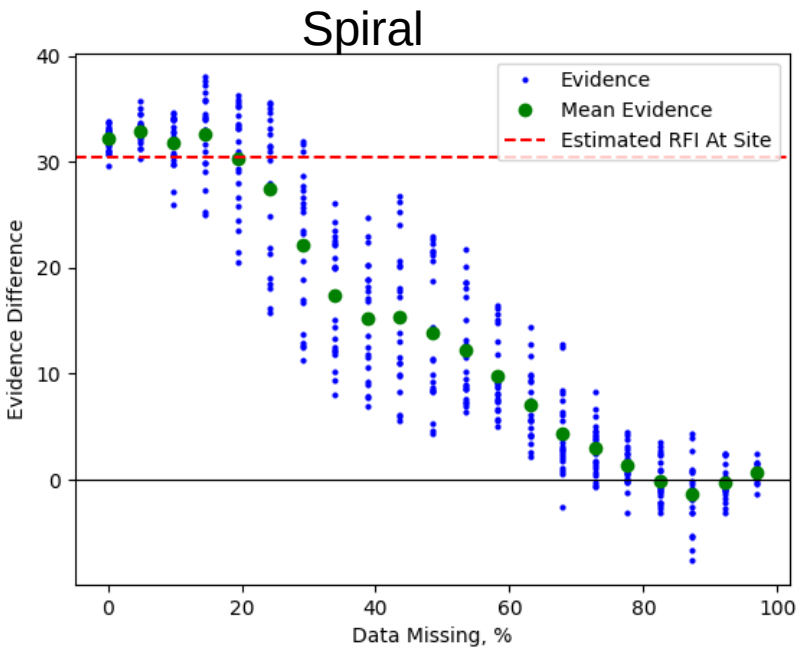
-How much data can we lose?

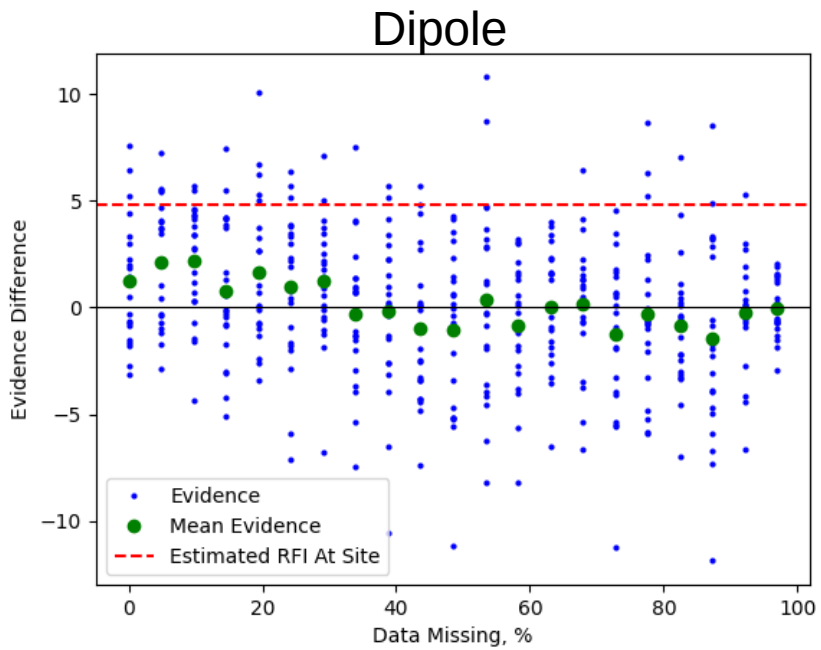




Excision + Management v)

-How much data can we lose (Evidence Difference)?

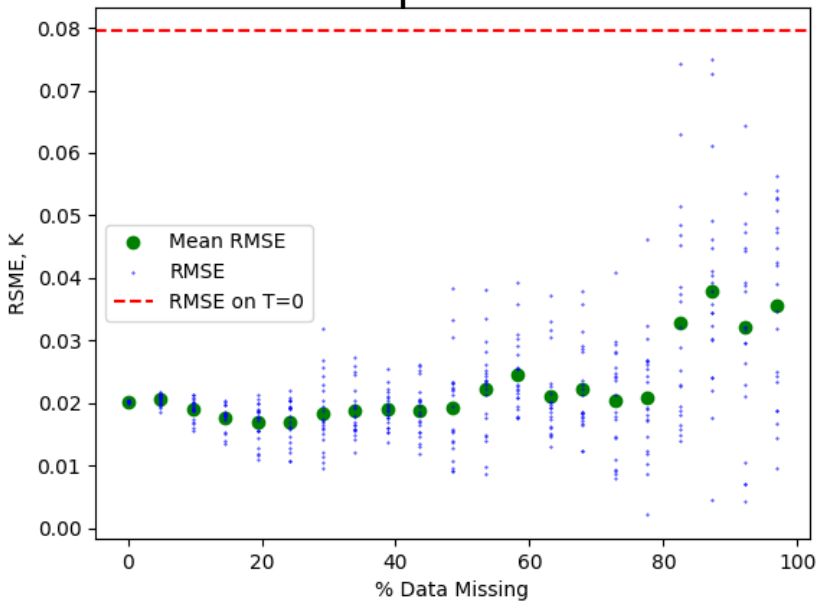




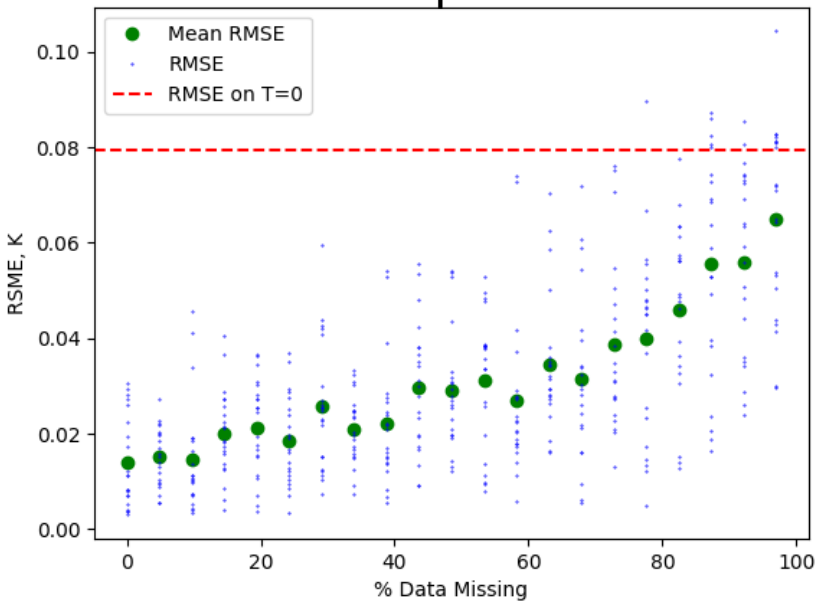
Excision + Management vi)

-How much data can we lose (RMSE)?

Spiral

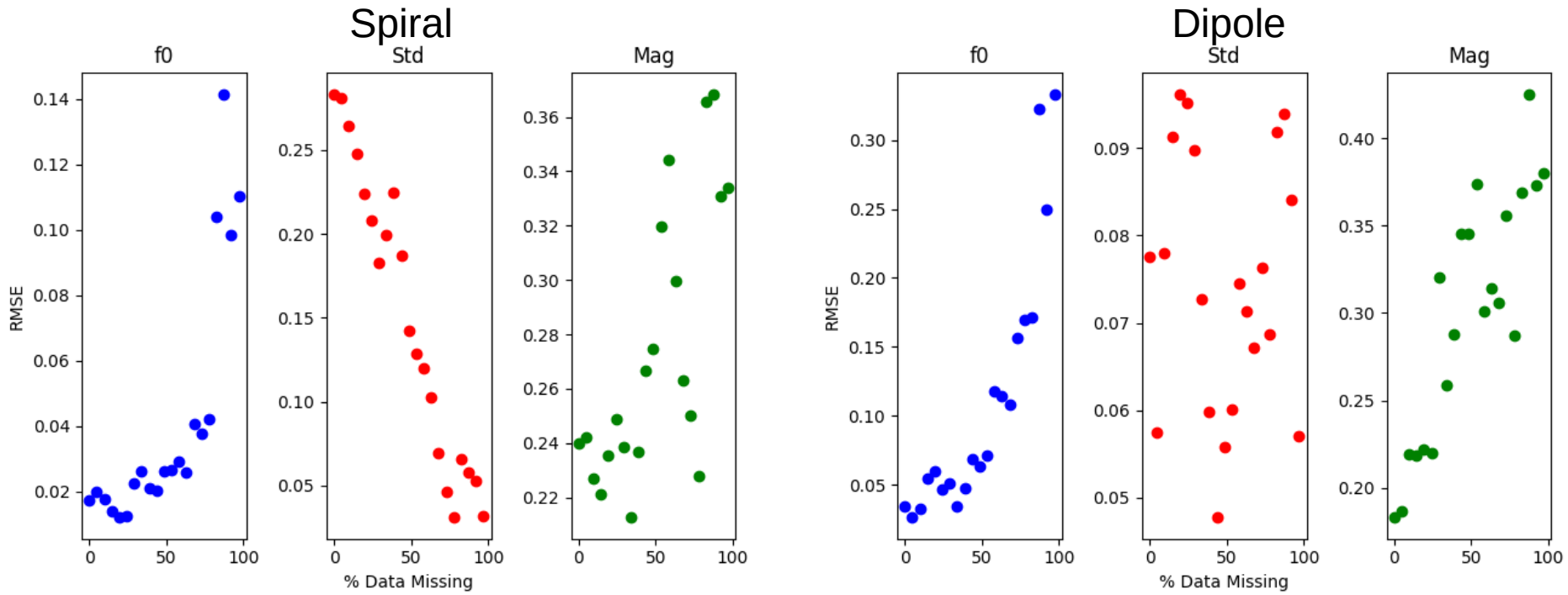


Dipole



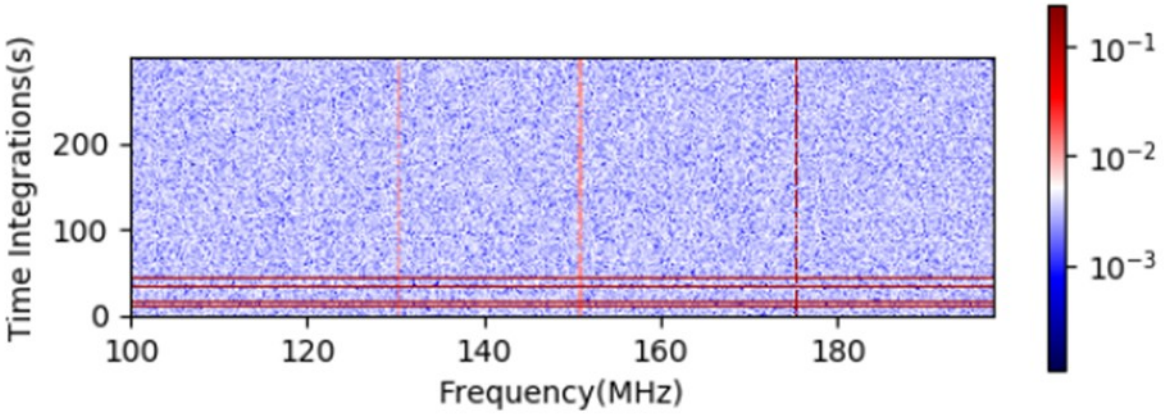
Excision + Management vii)

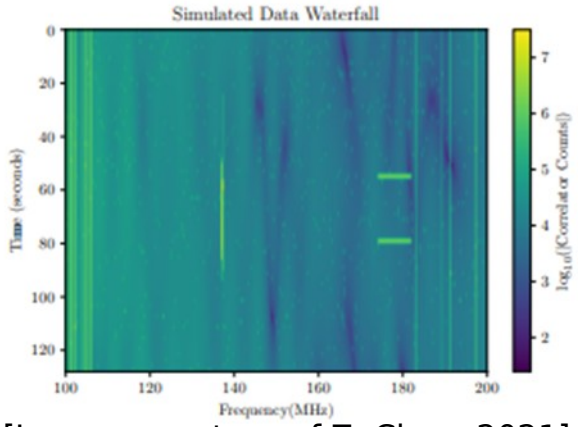
-How much data can we lose?



Flagging i)
-Types of RFI?

- Constant in time, narrowband.
- Temporary, broadband.
  - Can be problematic if >20% of data missing.
- Temporary, narrowband.
  - If flagged, can be dealt with
  - If unflagged is a major problem.



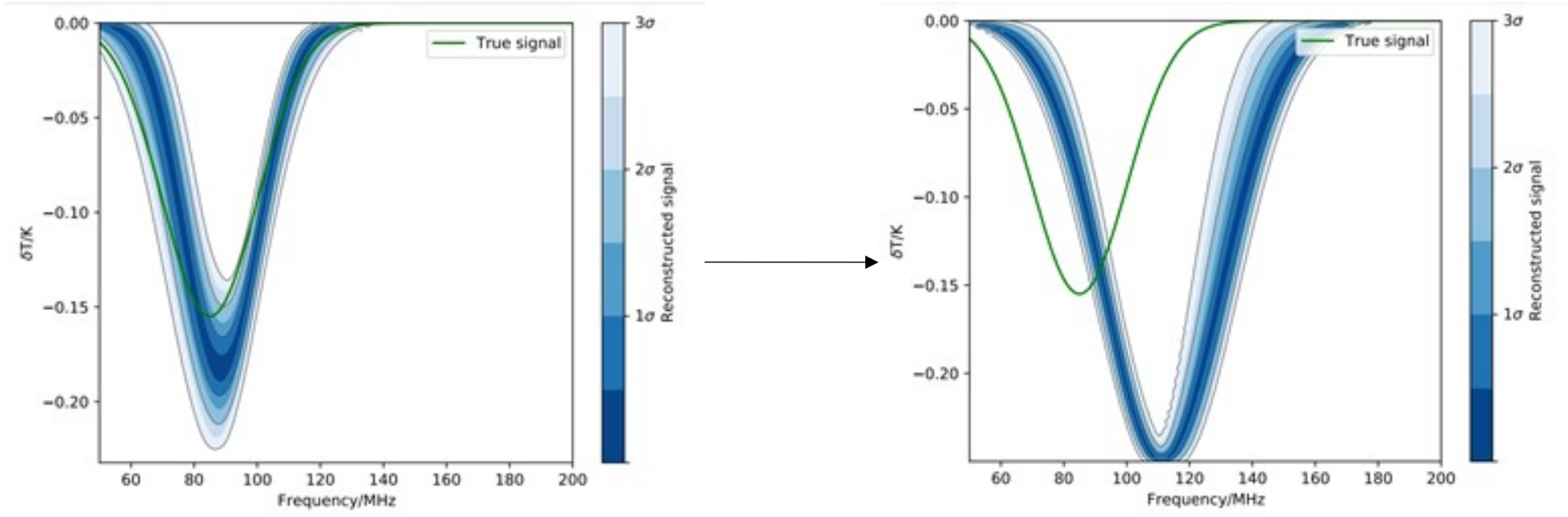


[Images courtesy of Z. Chen, 2021]

Flagging ii)

-Temporary, narrowband.

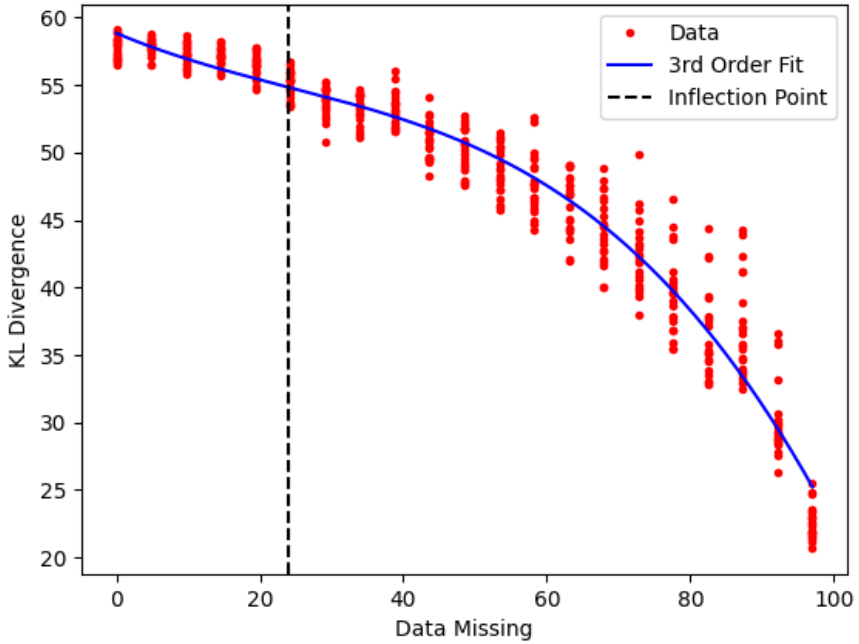
- Effect of 1Mhz unflagged RFI at 80Mhz



Flagging iii)

-Automating the detection of ‘too contaminated’ observations?

- The Kullback-Leibler divergence.
- Quantifies information provided by our data.
- Useful for:
  - Identifying time bins containing broadband RFI.
  - Unflagged narrowband RFI.



Next Steps?

- Is short time narrowband RFI less of a problem when time integrating?
- Experiment with various existing flagging models.
- Recent papers use CNN’s to flag RFI [x][x].
- Unsupervised learning?

Summary

- Pipeline very effective at managing flagged RFI.
- If RFI properly flagged, should be able to handle estimated levels on site.
- Unflagged RFI may cause problems.
- The pipelines efficacy will come down to our ability to effectively flag the RFI.

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